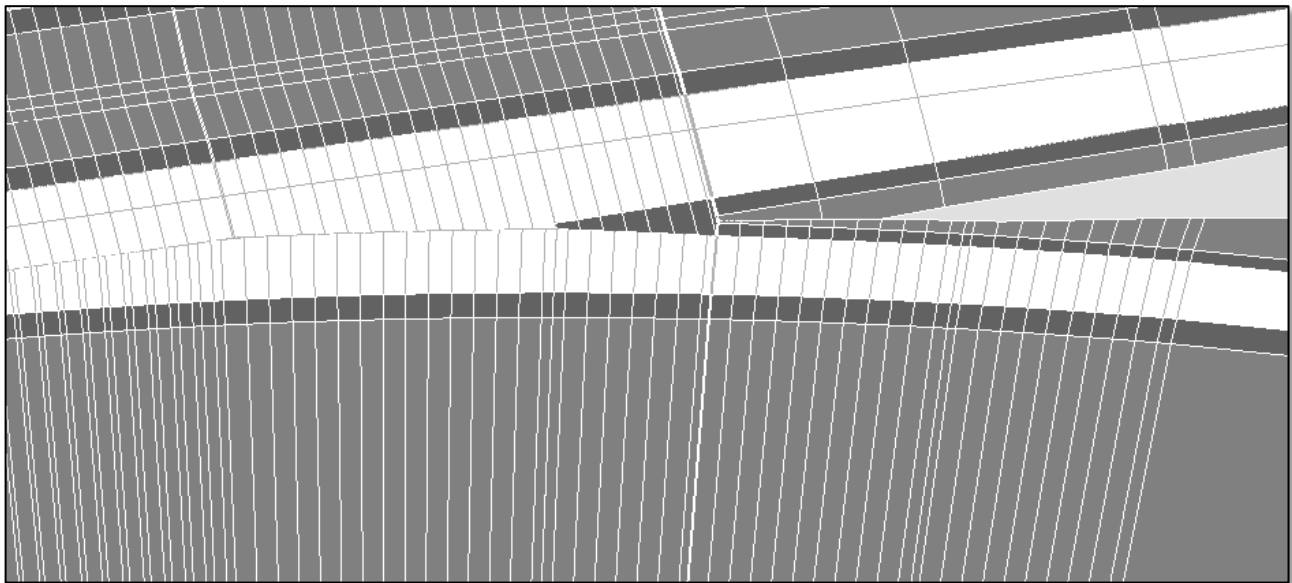


Chapter 18

Roadway Designer

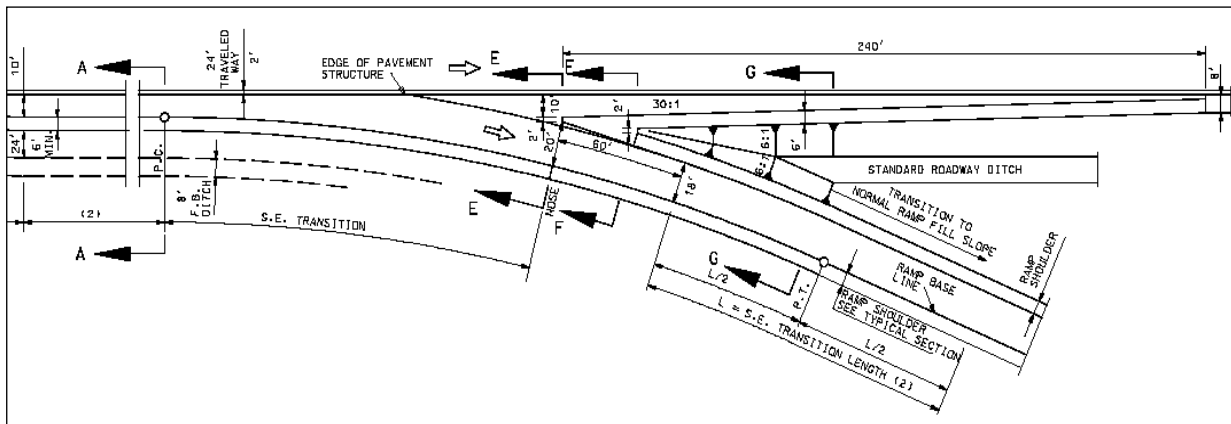
Ramp Transition Exercise



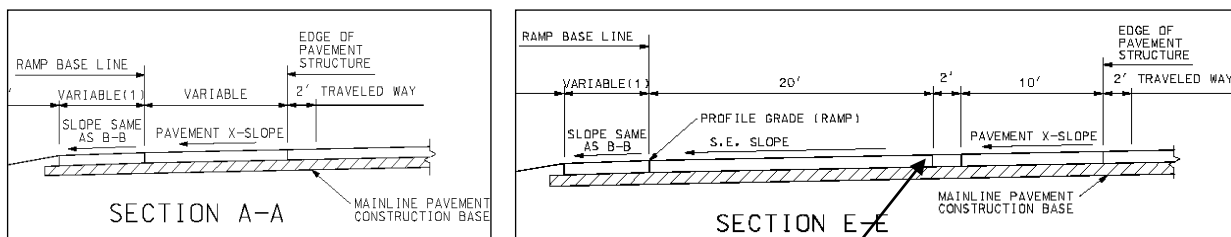
Ramp Transition Exercise

Objective and Background Information

The objective of this exercise is to demonstrate how the GEOPAK shape tools and COGO can be used to create a profile for a ramp transition. This is the area between the sections A-A and E-E in the following figure from Missouri Standard Plans for Highway Construction (203.41). The profile will be applied along the ramp chain.



As the figure indicates, the ramp is in superelevation transition from the pavement cross slope at Section A-A to the superelevation required for the beginning curve of the ramp at Section E-E. These two sections as shown in the standard plans are provided below.



The break in the slope between the mainline and the ramp can occur anywhere within these 2'

Before proceeding with the steps to create the profile, a decision needs to be made regarding the location of the break line between the mainline and ramp cross slopes. According to the Design Standards group, the exact location of this break line at Section E-E is not set. It can be located anywhere within the two-foot width of the ramp nose. For the purposes of this exercise, it will be located on the ramp side of the nose and held at a constant offset of 20' relative to the ramp chain from the ramp nose back to the point where this offset intersects with the mainline edge of pavement. As a designer, you can determine its location for your project.

Also needed is the superelevation rate at the ramp nose, which is based on the design speed of the ramp and the radius of the curve. The radius of the first curve in Ramp 2 is 1,041+ feet.

The relevant portion of the superelevation table from Missouri Standard Plan 203.20F is shown below. Based on $e_{\max} = 8\%$, the ramp's design speed of 40 M.P.H. and a rounded radius of 1000', the superelevation for the start of the ramp is 6.0%.

SUPERELEVATION AND WIDENING TABLE, $e_{\max} = 8\%$

DESIGN SPEED	30 M.P.H. OR LESS					40 M.P.H.					50 M.P.H.				
NORMAL SURFACE WIDTH			20'	22'	24'			20'	22'	24'			20'	22'	24'
RADIUS (FEET)	e%	L	W			e%	L	W			e%	L	W		
17000	NC	0	0	0	0	NC	0	0	0	0	NC	0	0	0	0
14000	NC	0	0	0	0	NC	0	0	0	0	NC	0	0	0	0
12000	NC	0	0	0	0	NC	0	0	0	0	NC	0	0	0	0
10000	NC	0	0	0	0	NC	0	0	0	0	NC	0	0	0	0
8000	NC	0	0	0	0	NC	0	0	0	0	NC	0	0	0	0
6000	NC	0	0	0	0	NC	0	0	0	0	RC	48	0	0	0
5000	NC	0	0	0	0	RC	41	0	0	0	2.4	58	2.0	0	0
4000	NC	0	0	0	0	RC	41	2.0	0	0	2.9	70	2.0	0	0
3500	NC	0	0	0	0	2.3	48	2.0	0	0	3.2	77	2.0	0	0
3000	RC	36	2.0	0	0	2.6	54	2.0	0	0	3.7	89	2.5	0	0
2500	RC	36	2.0	0	0	3.0	62	2.5	0	0	4.3	103	2.5	0	0
2000	2.4	44	2.5	0	0	3.7	77	2.5	0	0	5.1	122	2.5	0	0
1800	2.6	47	2.5	0	0	4.0	83	3.0	0	0	5.5	132	3.0	2.0	0
1600	2.9	53	2.5	0	0	4.4	91	3.0	0	0	5.9	142	3.0	2.0	0
1400	3.2	58	3.0	0	0	4.8	99	3.0	2.0	0	6.4	154	3.0	2.5	0
1200	3.6	65	3.0	2.0	0	5.4	112	3.5	2.5	0	7.0	168	3.5	2.5	0
1000	4.2	76	3.5	2.5	0	6.0	124	3.5	2.5	0	7.6	182	3.5	3.0	2.0
900	4.5	82	3.5	2.5	0	6.4	132	4.0	3.0	2.0	7.8	187	4.0	3.5	2.5

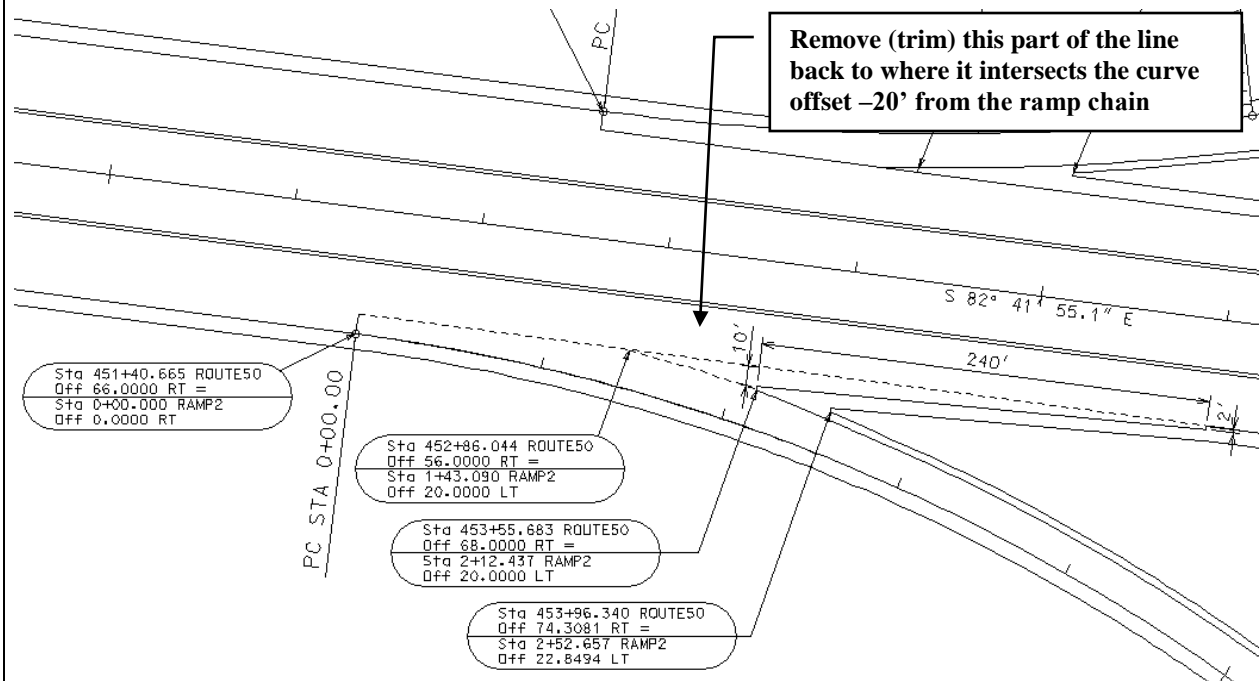
Procedure:

The following steps will be used to create the ramp profile:

1. In the plan view drawing, place a break line from **D&C Manager - EOP New** that indicates the location of the switch between the mainline and ramp slopes. This line is needed for the proposed cross sections.
2. In the shapes file, with the mainline shapes already plotted, place a line along the edge of the shape(s) next to the ramp. This line is to begin 5' before the beginning mainline station for the ramp transition and go to the ending mainline station of the transition.
3. Create a complex MicroStation element (using the same mainline station range as used in step 2) at the location of the break line created in the plan view drawing. Note that this line string will be longer at its beginning than the break line drawn in step 1.
4. Determine the cross slope on the ramp at each end of the transition. The cross slope at one end will match the mainline cross slope and will be at full superelevation for the ramp horizontal curve at the other end.
5. Use the Shape Analyst to find the elevation at the end of the break line as projected from the mainline shape next to the ramp. Based on this elevation and the cross slope for the ramp at this point, calculate the projected elevation along the ramp chain.
6. Store points along the ramp chain using the Shape Profiler in the continuous extrapolation mode to project the main line cross slope to the break line and the ramp cross slope from the break line to the ramp chain.
7. Re-station the points by create a dummy chain form the list with the beginning station set to match the ramp station at that point.
8. Create a point profile from the list of points, which will be the profile for the ramp transition.
9. Cut proposed cross sections for the transition area for RAMP2 only.

1. Open the MicroStation file **Plan.dgn**.

Adjust the window area to the beginning of Ramp 2, as shown below. The white dashed lines indicate the location of the mainline edge of pavement at the ramp and the -20' offset from the ramp chain. Several key points are labeled giving the station and the offset of the point relative to the mainline (**ROUTE50**) and ramp (**RAMP2**) chains.



Trim the east (right) end of the dashed line showing the mainline edge of pavement back to where it intersects the curve offset -20' from the ramp. This line represents the break in EOP for the transition area. Using the **D&C Manager "SET"** tool, define the trimmed lines as **EOP New**. Use the same Adhoc setting from the other EOP line in the dgn. **Save the changes to the DGN.**

Enter the GEOPAK project **pw:\DistrictCADD\design\Cole\J5P0100\project\j5p0100.prj** as **userc**.

2. Using the Superelevation Shape Manager tools visualize the **shape_ROUTE50.inp**

Use the shape analyst tool to determine the elevation projected from the mainline shapes where the break line intersects the ramp nose. This elevation will be used to determine the elevation for last VPI in a point profile for the ramp transition. The Shape Profiler will be used later to generate the rest of the VPI elevations. Activate **Superelevation Shape Manager Tools**

2. Select the **Shape Analyst** from the dialog. It is the forth icon from the left as shown in the figure.

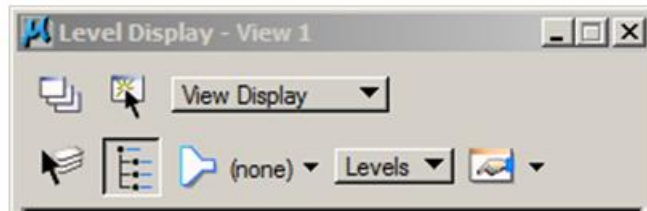


The **Shape Analyst** tool is shown below.

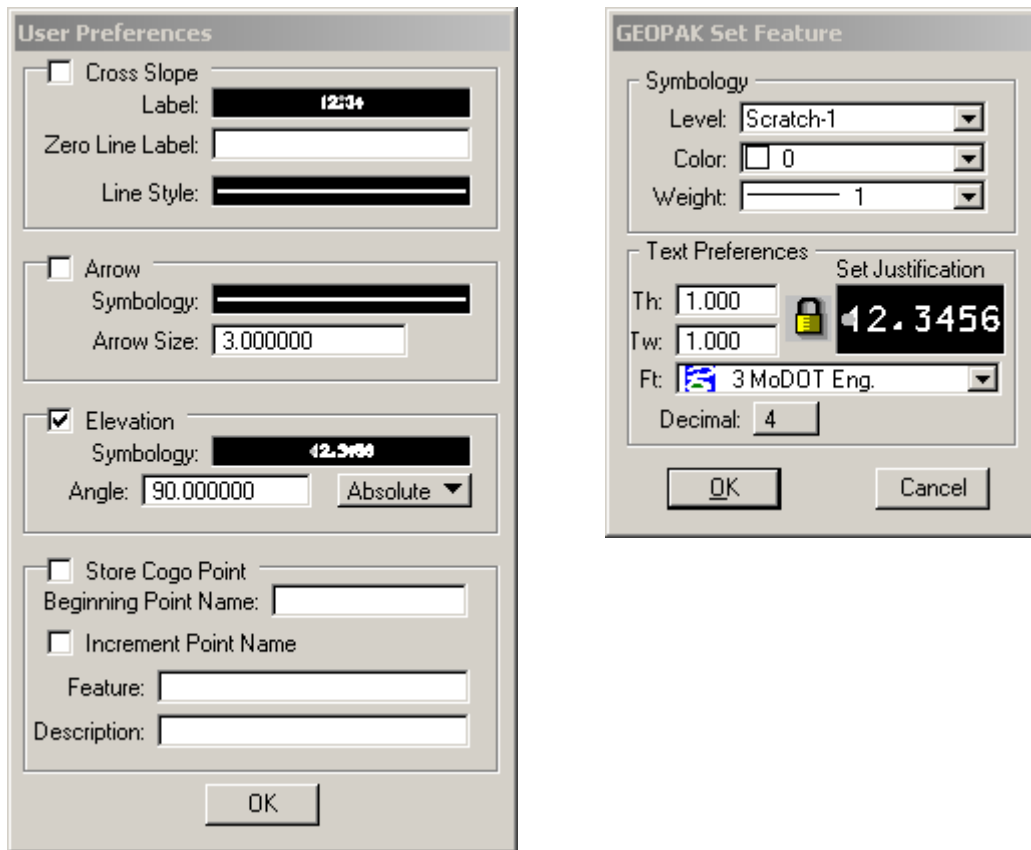
- In the Shape Analyst, shown below, toggle on **Display Only**, select the **DP** button, and first data point inside the **Gold** (color-5) shape for Route 50 and then at the **start of the ramp**. This lets us know that the **cross slope for Route 50 at this point is -2%**. It provides other information about the shape as shown in the dialog. You will have different information based on the location of your DP.

The "Shape Analyst" dialog box is shown. It has a title bar with a blue icon and the text "Shape Analyst". Below the title bar is a "User" label. The "Job" field contains "101" with a search icon. There are two checkboxes: "Display Only" (checked) and "Cross Section" (unchecked). A section titled "Elevation Information" contains several fields: "Chain" (ROUTE50), "Profile" (ROUTE50PR), "Station" (451+40.67 R 1), "Offset" (65.999929), "Elevation" (728.377), "PGL Elevation" (728.617), "PGL Slope" (0.00 %), "Cross Slope" (-2.00 %), "Longitudinal Slope" (empty), and "Flow Slope" (empty). At the bottom, there is an "Extrapolate Fixed Slope" checkbox (unchecked) and a text field showing "-2.000000 %". Three buttons are at the bottom: "By Sta/Offset", "DP" (highlighted with a blue box), and "Dynamic".

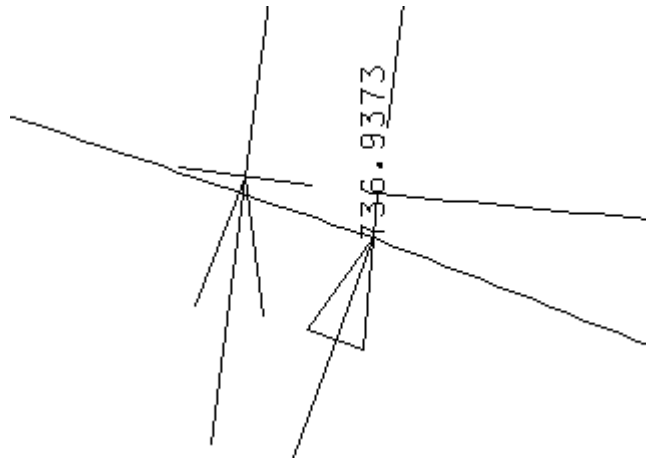
3. Go to the MicroStation **Level Display** and make sure the Level Filter is set to **All Levels** or **None**.



4. Open **User > Preferences** and toggle on **Elevation**, set the text settings as shown below right.



- Close the dialog by clicking on **OK**.
- **Turn off Display Only.**
- Select the **DP** button, **snap** to the **outside pavement edge of the ramp nose (Route 50 Sta. 453+55.683, offset 68' to the right)**, and data point to accept. The elevation at this location is **736.9373** as projected from the **Route 50 shapes**.

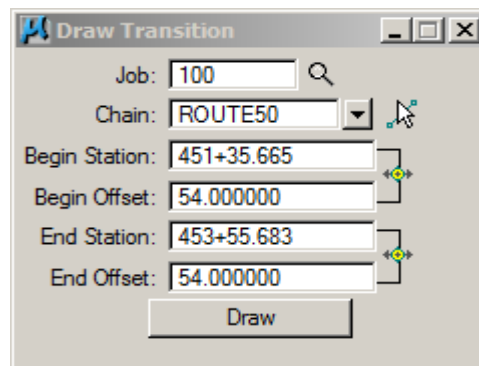


Calculating Ramp 2 Profile - [Method One](#):

6. The **Shape Profiler** can be used to extrapolate the elevations from the mainline shapes onto the ramp chain to locate the VPIs for the profile. Elevations will be determined at **5'** increments. Before doing this, lines need to be added to the **Ramps_Shapes.dgn** file to let the profiler know how to extrapolate the elevations.

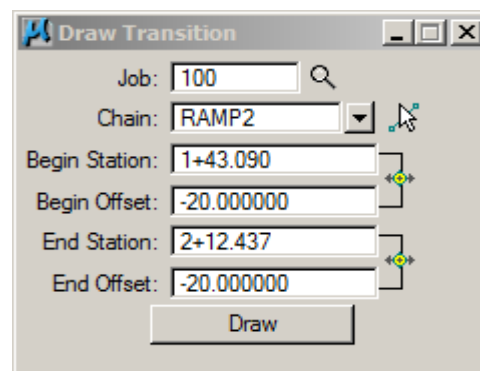
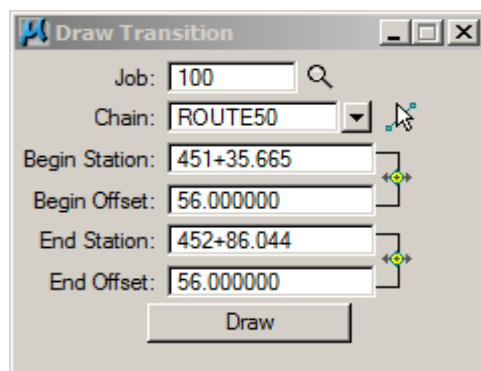
The first line needs to be along the outside edge of the mainline shapes start **5'** before the ramp transition and going to the other end of the transition. For this project the line needs to run from **Route 50** station **451+35.665** (**5'** before the start of the ramp) to station **453+55.683**, which is the mainline station at the ramp nose, with a constant offset of **54'**

Use the **Draw Transition** tool to place a **Red** line on **Level Scratch-2** at a constant offset of **54'** from **Route50**, Station **451+35.665** to **453+55.983**.

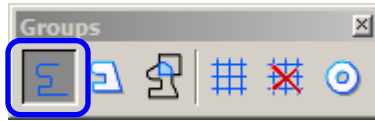


The second line needs to be a single element that defines the change in cross slope. For this project the line will be offset **56'** from **Route 50 Station 451+35.665** to **Station 452+86.044**, which is the same a **Ramp 2 Station 1+43.090** with an offset of **-20'**. The line continues from that point with a constant offset from **Ramp 2 Station 1+43.090** to **Station 2+12.437**.

Use **Draw Transition** to place a **Red** line on level **Scratch-2** at a constant offset of **56'** from **Route 50 Station 451+35.665** to **452+86.044**. Draw a second line with a constant offset of **-20'** from **Ramp 2 Station 1+43.090** to **Station 2+12.437**.

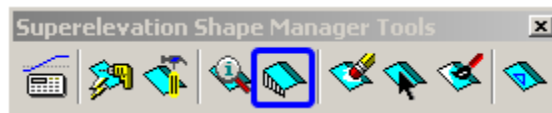


7. Using the MicroStation **Create Complex Chain** tool to create a single element from these two red lines. The tool is the one selected in the MicroStation Groups toolbox shown below.



*** To make this process easier, in the **Reference Dialog** turn off the **Rte50_plan.dgn**.

8. **Open the Shape Profiler.**

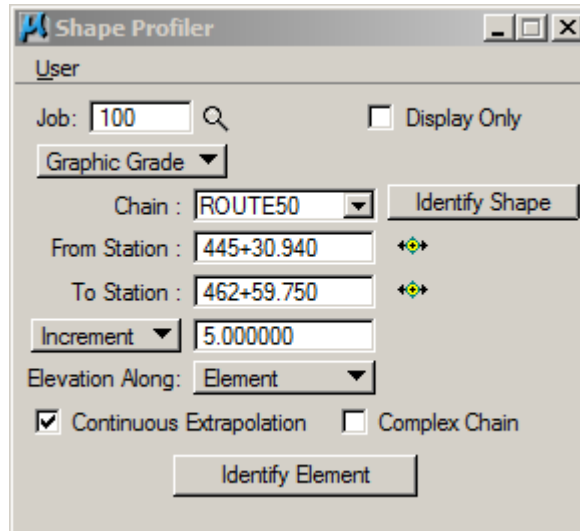


The Shape Profiler uses the same User Preferences dialog as the Shape Analyst. Go to **User > Preferences** and toggle **OFF** the **All Options** as shown below since the Slope, Elevations, and Arrow at the edge of the shape are not needed.

A screenshot of the 'User Preferences' dialog for the Shape Profiler. The dialog is organized into four sections, each with a checkbox and associated settings. The first section, 'Cross Slope', has a checkbox that is unchecked, a 'Label' field with '1234', a 'Zero Line Label' field, and a 'Line Style' field. The second section, 'Arrow', has a checkbox that is unchecked, a 'Symbology' field, and an 'Arrow Size' field with '3.000000'. The third section, 'Elevation', has a checkbox that is unchecked, a 'Symbology' field with '12.345', an 'Angle' field with '0.000000', and a 'Relative' dropdown menu. The fourth section, 'Store Cogo Point', has a checkbox that is unchecked, a 'Beginning Point Name' field, an 'Increment Point Name' checkbox, a 'Feature' field, and a 'Description' field.

Click **OK** to save the changes to the preferences.

9. Click on **Identify Shape** in the Shape Profiler and **select the edge of the color-5 shape for Route 50 adjacent to the Ramp 2**. This will fill-in the Chain field in the dialog as well as the shape's from and to station values.

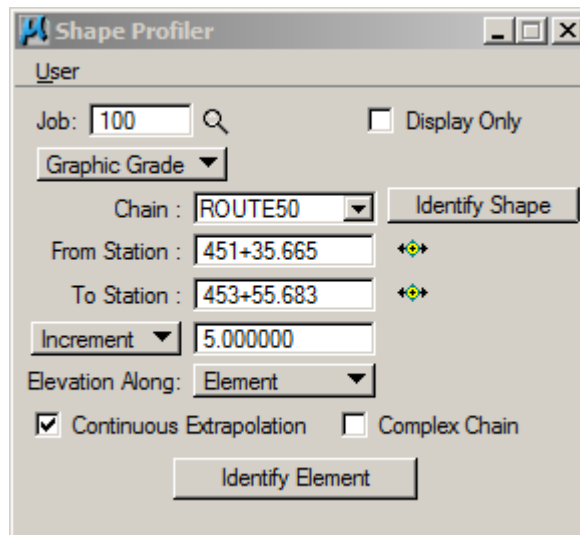


The Shape Profiler dialog box is shown. It has a title bar with a blue icon and the text 'Shape Profiler'. Below the title bar is a 'User' section. The 'Job' field contains '100' and has a magnifying glass icon. To the right is a 'Display Only' checkbox. Below 'Job' is a 'Graphic Grade' dropdown menu. The 'Chain' field contains 'ROUTE50' and has a dropdown arrow. To the right is an 'Identify Shape' button. Below 'Chain' are 'From Station' and 'To Station' fields. 'From Station' contains '445+30.940' and 'To Station' contains '462+59.750'. Both have double-headed arrows to their right. Below these is an 'Increment' dropdown menu containing '5.000000'. Below that is an 'Elevation Along' dropdown menu containing 'Element'. At the bottom are two checkboxes: 'Continuous Extrapolation' (checked) and 'Complex Chain' (unchecked). Below these is an 'Identify Element' button.

This space was intentionally
left blank

10. Click on the **DP** button next to the “**From Station**” field and **snap on the end of the complex element** created in the previous step **near the beginning of Ramp 2**. Accept the snap.

Click on the **DP** button next to the **To Station** field and **snap on the end of the same element at the ramp nose**. Accept the snap. This will set the station range for the Shape Profiler.



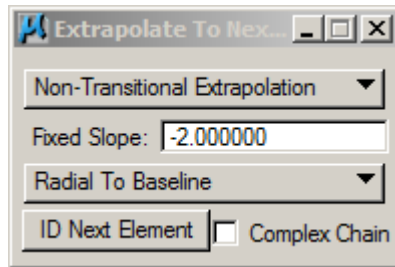
Set the distance between points option to an **Increment** of **5**, as show in the above dialog figure. This area of the dialog is directly below the station range fields.

Set **Elevation Along**: to **Element** - It is not necessary for the element to be within the superelevation shape. Any elevations outside the shape are calculated by projecting from the edge of the shape at the superelevation slope.

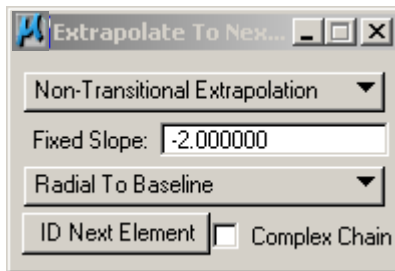
Set **Continuous Extrapolation**: to **ON** - Continuous extrapolation is utilized so that elevations along any MS elements may be determined.

Set **Complex Chain**: to **OFF** - If the Complex Chain toggle is active, the user may select a string of elements. If the toggle is off, the user may select a single element.

11. Click on the **Identify Element** button and select line created in the previous step that runs along the edge of the **Route 50 shape**. This will bring up the following dialog:

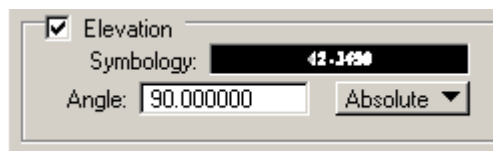


12. Set up the dialog as shown below. This tool will project elevations from the edge of the shape selected onto the next element chosen. This extrapolation can be **Non Transitional** or **Transitional**, which is chosen at the top of the dialog. The next part of the dialog is used to set the slope and direction of the extrapolation, which can be **Radial To Baseline** (used for the shape), **Radial From Element** (which is the current element), or **Radial To Element** to be chosen next.

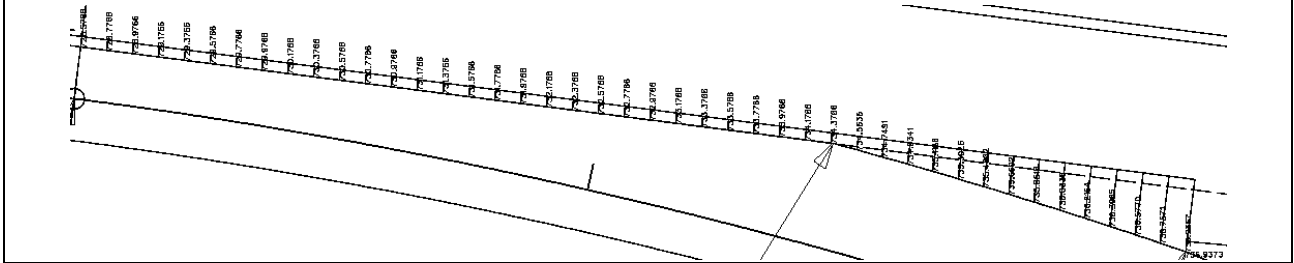


Since the next element chosen will be the line representing the change in cross slope, the slope to the next element is the same slope as the mainline shape. In this example the mainline shape is non transitional with a cross slope of -2%, which is the value to be used. If the shape were in superelevation transition, the Transitional Extrapolation option would be used. The “**From Slope**” equaling the cross slope of the shape and the start of the ramp transition area and the “**To Slope**” set to the cross slope of the shape at the other end of the ramp transition or the end of the shape, whichever comes first.

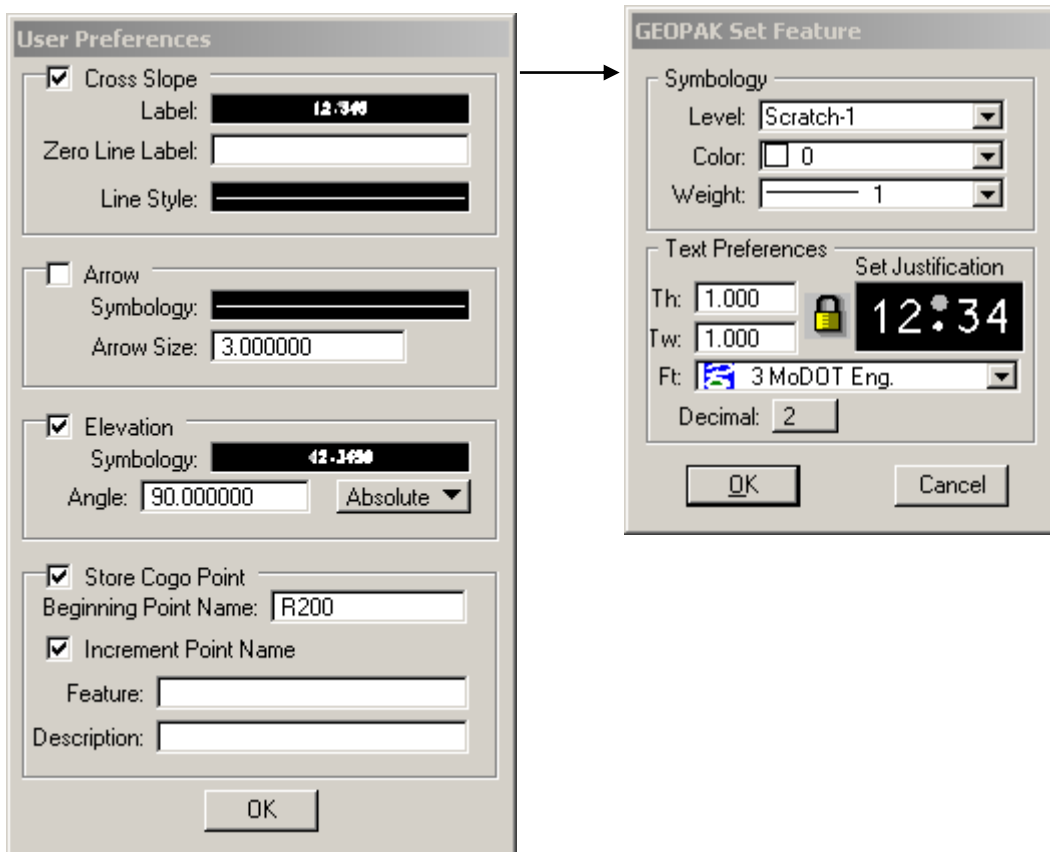
For the class example, plot the elevation along the next element chosen. To do this, go to **User > Preferences** in the Shape Profiler and **toggle on the Elevation option** as shown below. Click **OK** at the bottom of User Preferences to accept the change.



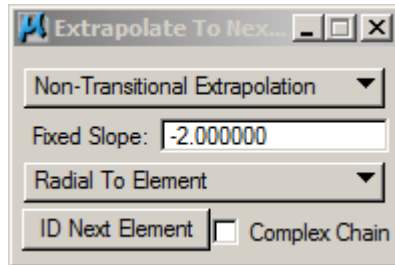
13. In the Extrapolate to Next Element dialog, click on the **ID Next Element** button and select the complex element created in the previous step. You should get the following results:



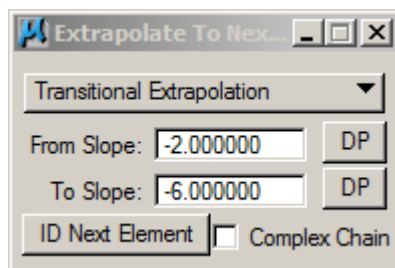
14. The next projection is from the element just identified to the ramp chain. Since the elevations from the next projection will be used to create the profile for the first part of the ramp, preferences need to be changed. Also, it would be nice to see the change in the cross slope at each point in the projection to verify that it is being done correctly. To change the preferences, go to **User > Preferences** in the Shape Profiler and **toggle on Cross Slope** and **Store Cogo Point**, as shown in the figure below. Click **OK**, to close the User Preferences dialog.



15. This extrapolation needs to be radial to the ramp chain since that is the direction of the cross slope for the ramp. To do this, switch the projection option to **Radial to Element** in the Extrapolate to Next Element dialog as shown below.



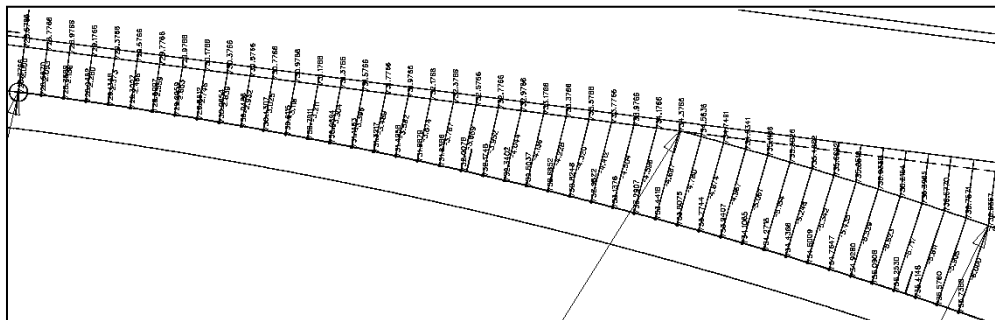
16. Because the ramp cross slope is in transition, change the first option to **Transitional Extrapolation**. This will change the dialog to the form shown in the next figure.



Set the **From Slope:** to **-2** and the **To Slope:** to **-6** as to the left. Click on the **From Slope: DP** and place a data point at the **start of the ramp**. Click on the **To Slope: DP** and place a data point at the **ramp nose**. The offset of these data points can be anywhere on or between the break line and the ramp chain. It is the station value that is used and not the offset.

*** Make sure **COGO** is **Open**, **Visualization** set to **Permanent**, and the **Plot Scale = 10**.

Click on the **ID Next Element** button and select the **ramp chain**. The results are shown in the figure to the bottom.



17. **Close the Shape Profiler.** If you look closely at the last projection line you will notice that is just short of the ramp nose. It was because of this that the Shape Analyst was used to project the Route 50 cross slope to the break line. Consequently, the elevation for the VPI for the ramp profile at the nose of the ramp needs to be calculated. It is the elevation at the nose end of the break line + the cross slope on the ramp at that point time the distance from the break line to the ramp. For this example the calculation is:

$$\text{VPI elevation} = 736.9373 + (-6\% * 20') = 736.9373 - 0.06 * 20$$

$$736.9373 - 1.2 = \mathbf{735.7373}$$

This elevation will be used for the last VPI of the **Ramp 2 Transition (Station 2+12.437)**.

18. Open the COGO Navigator and look at the list of points. Scroll down until you get to Point R200. Click on **R200 to highlight that point**. Scroll down to the last point in the range. It should be point **R243**. **Hold down the shift key and click on the last point in the range to select all points in the range**. Describe the points. Notice that the points are about 5 feet apart and the stationing corresponds to that from the mainline.

Coordinate Geometry Job: 100 Operator: cu

File Edit Element View Tools

9+99(9).12 12+34 Bearing XY << < > >>

COGO Key-in: PRINT POINT R241 R242 R243

<* 1 PRINT POINT R200 R201 R202 R203 R204 R205 R206 R207 R208 R209 R210 R219 R220 R221 R222 R223 R224 R225 R226 R227 R228 R229 R230 R231 R232 R233 R234

Point	X	Y	Station	Elevation
R200	1,698,698.74	999,408.47	451+40.67	728.3768
R201	1,698,703.65	999,407.83	451+45.62	728.5672
R202	1,698,708.56	999,407.17	451+50.57	728.7571
R203	1,698,713.46	999,406.48	451+55.53	728.9464
R204	1,698,718.36	999,405.77	451+60.48	729.1350
R205	1,698,723.26	999,405.03	451+65.43	729.3228
R206	1,698,728.15	999,404.28	451+70.37	729.5099

19. Before the points can be used to create a profile for the ramp, they need to be re-stationed to match the ramps stationing. To get an exact stationing, you would need to use the inverse along chain command to get the station values and then apply the corresponding station to each point one at a time. Because the points were spaced relatively close together, a short cut method can be used with virtually identical results. The short cut is to create a chain consisting of the range of points that begins at the appropriate station value. However, a slight inaccuracy is introduced because this chain goes from point to point, rather than along the curve of the ramp chain.

Create chain RAMP2TR beginning at station 0+00 and consisting of the points R200-R243 as shown in the dialog below.

Using the Inverse Tool along the **Ramp 2 chain** indicates that **point R243** is at **Ramp 2 Station 2+12.4186**. Describing the **RAMP2TR** chain indicates point **R243** has been assigned the **Station 2+12.4184**. Thus an inaccuracy is introduced, but the inaccuracy is not significant.

```
<*      3      Inverse Along RAMP2 R200-R243
```

Point	North	East	Station/Region	Offset	Distance
R242	999,361.8735	1,698,900.4956	2+07.4115 1	0.0000	5.0071
R243	999,360.2560	1,698,905.2343	2+12.4186 1	0.0000	

```
<*      7      DESCRIBE CHAIN RAMP2TR
```

```
Point R242          N      999,361.8735 E   1,698,900.4956 Sta      2+07.4113
Course from R242 to R243 S 71° 09' 12.04" E Dist 5.0071
Point R243          N      999,360.2560 E   1,698,905.2343 Sta      2+12.4184
```

```
=====
Ending chain RAMP2TR description
```

20. The next step is to create the profile for the transition area in Ramp 2. A key-in command needs to be used for this step. It has the following format: **STORE PROFILE name pa-pi**. Type in the following COGO command:

S PRO Ramp2PR R200-R243

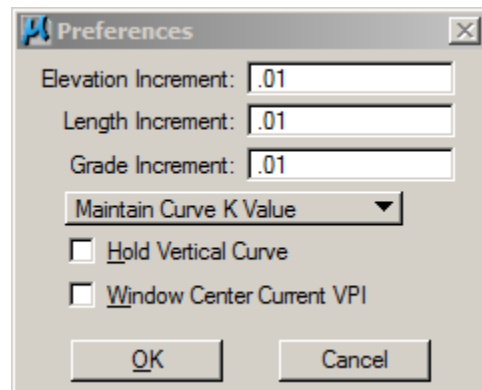
Exit Coordinate Geometry.

21. Open the MicroStation file **profile_J5P0100.dgn**. Go to the MicroStation Utilities Pull-Down Menu and select **Saved Views** and pick the **RAMP2** saved view.

Select the **Ramp2** Working Alignment.

22. In the next few steps we are going to finish creating the Ramp2PR profile for the entire limits of the Ramp 2 Chain. To finish storing the profile open the **Vertical Alignment Generator** located on the Road Dialog.

Select **File > Preferences** and change the **Elevation** and **Length Increment** to 2 decimal places, as shown in the figure to the right.



Select **File > Load** and load **Ramp2PR** profile.

Go to **VPI 44** (last VPI) and change the following:

<u>Station</u>	<u>Elevation</u>	
2+12.437	735.7373	(From Step 17)

This will move the VPI from point **R243's** station and elevation to the ramp pavement nose. Note that the back grade is now **3.21%**. Later a new **VPI** will be inserted using a back grade rounded down to **3.20%**.

The profile needs to be extended for the rest of the ramp. This will be a two-part process. The first part will be to add a VPI based on the end of the ramp tying into the Bighorn crossroad. After this a new VPI will be inserted before the last VPI and it will be set using grade information.

23. The last VPI for the Ramp2PR profile will be where the ramp chain **crosses the Bighorn crossroad gutter line**. This point is **offset 18.5'** from the crossroad centerline. The elevation of the crossroad at this point and corresponding ramp station has already been determined below. Based on this, **insert a VPI at the end of the profile using the following VPI station and elevation**.

<u>Station</u>	<u>Elevation</u>
16+36.81	763.92

The dialog with the newly inserted VPI is shown below.

The screenshot shows the 'Profile Generator' dialog box with the 'Active Profile: RAMP2PR' and 'K Value Table: KValues_2001english.kvl'. The 'VPI 45' section is highlighted with a blue box, showing the following data:

Station	Elevation
16+36.81	763.92

Other VPI data visible includes VPI 44 (Station: 2+12.44, Elevation: 735.74) and VPI 46 (Station: 16+36.81, Elevation: 763.92). The 'Back Grade' for VPI 45 is set to 1.98 and 'Length' is 1424.37.

To enter the remaining VPI, press on the **Insert Before** button. This will insert a new **VPI 45** with the just modified VPI moving to **VPI 46**. At the new **VPI 45**, set the back grade to **3.20%** and hit the **tab** key. This will lock that value. Set the forward grade to **1.00%** and hit the **tab** key once again. This will lock that value and adjust the station and elevation for the VPI, as shown in the following figure. Enter a **Vertical Curve Length** of **820'**.

The screenshot shows the 'Profile Generator' dialog box with the 'Active Profile: RAMP2PR' and 'K Value Table: KValues_2001english.kvl'. The 'VPI 45' and 'VPI 46' sections are highlighted with blue boxes, showing the following data:

VPI	Station	Elevation	Back Grade	Forward Grade	Length
VPI 45	8+46.03	756.01	3.20	1.00	633.59
VPI 46	16+36.81	763.92			790.78

The 'Symmetrical Vertical Curve' section is also visible, showing a 'Speed' of 75, 'L' of 820.00, and 'K' of 372.7298. The 'HP Station' is 12+56.03 and 'HP Elevation' is 760.11. The 'SSD' is 900.46. The 'Station' for the curve is 4+36.03 and 'Elevation' is 742.89.

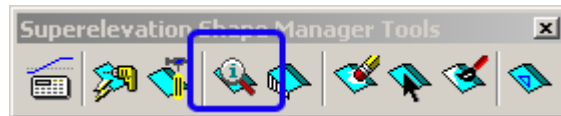
24. **Save** the profile as **Ramp2PR** and exit the **Vertical Alignment Generator**.

*** In order to save the profile, the COGO Redefine setting must be toggled on.

You may use D&C Manager to plot the profile **Ramp2PR**. If you do so **save** changes the MicroStation drawing.

Calculating Ramp 2 Profile - [Method Two](#):

25. Select the **Shape Analyst** from the dialog. It is the forth icon from the left as shown in the figure.



The **Shape Analyst** tool is shown below.

- In the Shape Analyst, shown below, toggle on **Display Only**, select the **DP** button, and first data point inside the **Gold** (color-5) shape for Route 50 (near the beginning of the ramp) and then at the baseline location at the **Start of the Ramp**. This lets us know that the **cross slope for Route 50 at this point is -2%**. It provides other information about the shape as shown in the dialog. You will have different information based on the location of your DP.

The image shows the "Shape Analyst" dialog box. At the top, there is a "User" label. Below it, the "Job" field is set to "100". There are two checkboxes: "Display Only" (checked) and "Cross Section" (unchecked). A section titled "Elevation Information" contains several fields: "Chain" is set to "ROUTE50", "Profile" is "ROUTE50PR", "Station" is "451+40.67 R 1", "Offset" is "65.999938", and "Elevation" is "728.377". To the right of these are "PGL Elevation" (728.617), "PGL Slope" (0.00 %), "Cross Slope" (-2.00 %), "Longitudinal Slope" (4.00 %), and "Flow Slope" (4.47 %). At the bottom, there is an unchecked checkbox for "Extrapolate Fixed Slope" with a value of "0.000000 %". Three buttons are at the bottom: "By Sta/Offset", "DP" (highlighted with a blue box), and "Dynamic".

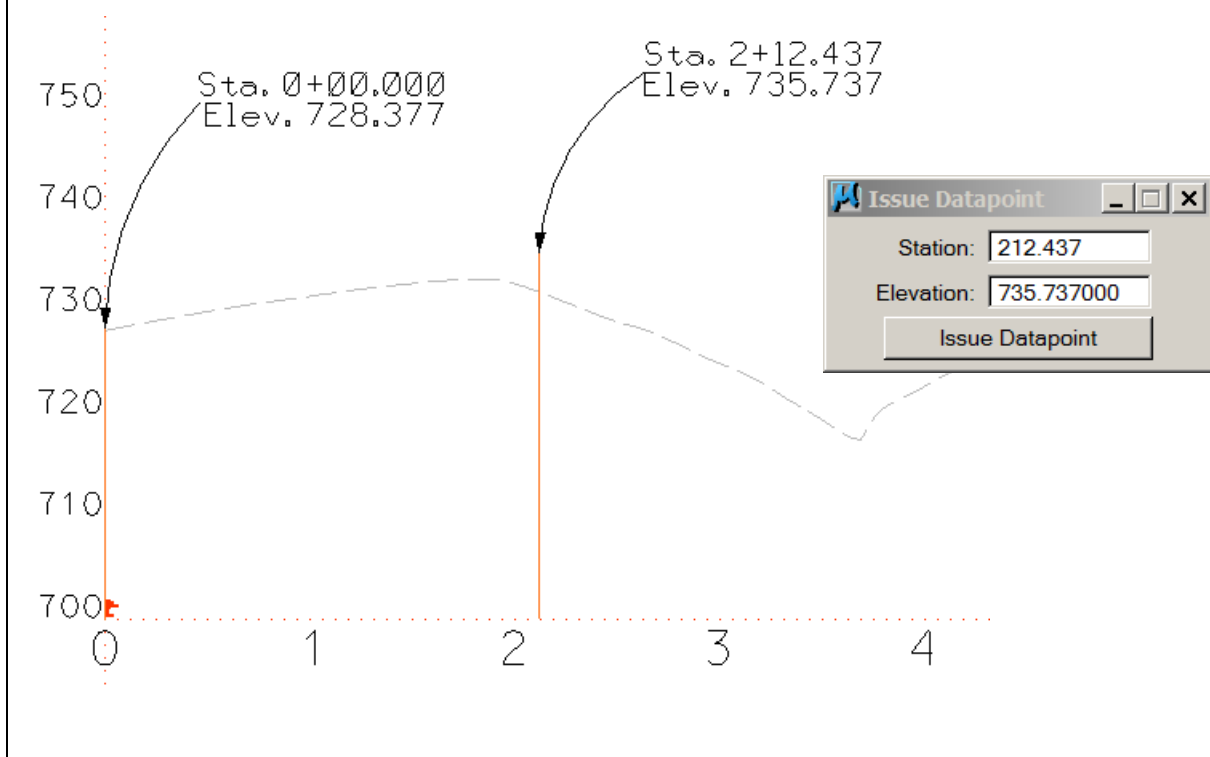
26. Using the **Shape Analyst** tool project the Route 50 cross slope to the break line location of the pavement gore point. The elevation for the VPI for the ramp profile at the nose of the ramp needs to be calculated. It is the elevation at the nose end of the break line + the cross slope on the ramp at that point times the distance from the break line to the ramp. For this example the calculation is:

$$\begin{aligned}\text{VPI elevation} &= 736.9373 + (-6\% * 20') = 736.9373 - 0.06 * 20 \\ &= 736.9373 - 1.2 = \mathbf{735.7373}\end{aligned}$$

This elevation will be used for the elevation of Ramp 2 at the Pavement Gore Location (**Station 2+12.437**).

27. Open the MicroStation file **Profile.dgn**.

28. Using the **Vertical Alignment Generator** and **Profile Labeler** locate and label the **Ramp 2** start and gore point in the profile view.



29. Using the **Vertical Alignment Generator** to create the profile from the start of the start of the ramp to the gore point.

<u>VPI</u>	<u>Station</u>	<u>Elevation</u>	<u>Back Grade</u>	<u>Vertical Curve</u>
1	0+00.000	728.377		
2	1+06.220		4.00%	212.44
3	2+12.437	735.7373		

25. The last VPI for the **Ramp2PR** profile will be where the ramp chain **crosses the Bighorn crossroad gutter line**. This point is **offset 18.5'** from the crossroad centerline. The elevation of the crossroad at this point and corresponding ramp station has already been determined below. Based on this, **insert a VPI at the end of the profile using the following VPI station and elevation**.

<u>Station</u>	<u>Elevation</u>
16+36.81	763.92

The dialog with the newly inserted VPI is shown below.

The screenshot shows the 'Profile Generator' dialog box with the title 'K Value Table: KValues_2001english.kvl'. It has a 'File' menu and a 'Tools' button. The dialog is divided into two main sections for VPI 3 and VPI 4.

VPI 3 Section:

- Station: 2+12.44
- Elevation: 735.74
- Back Grade: 1.9786 (with an 'Off' dropdown arrow)
- Length: 1424.37

VPI 4 Section:

- Station: 16+36.81 (with an 'Off' dropdown arrow)
- Elevation: 763.92 (with an 'Off' dropdown arrow)

Below the VPI 4 section are four buttons: '<< Insert', 'Dynamic', 'Delete', and 'Insert >>'. At the bottom of the dialog, there is a 'Previous' button, a page indicator showing '1' of '4', and navigation arrows.

26. To enter the remaining VPI, press on the **Insert Before** button. This will insert a new **VPI 4**. At the new **VPI 4**, set the back grade to **2.932%** and hit the **tab** key. This will lock that value. Set the forward grade to **1.00%** and hit the **tab** key once again. This will lock that value and adjust the station and elevation for the VPI, as shown in the following figure. Enter a **Vertical Curve Length** of **820'**.

The screenshot shows the 'Profile Generator' window with the following data:

VPI 3	VPI 4	VPI 5
Station: 2+12.44	Station: 9+33.94	Station: 16+36.81
Elevation: 735.74	Elevation: 756.89	Elevation: 763.92
Back Grade: 2.9320 (locked)		Fwd Grade: 1 (locked)
Length: 721.50		Length: 702.87

Below the VPI data, the 'Symmetrical Vertical Curve' section shows:

Speed: 80	L: 820.00	K: 424.4306
Station: 5+23.94	HP Station: 13+43.94	SSD: 968.49
Elevation: 744.87	HP Elevation: 760.99	

27. **Save** the profile as **Ramp2PR** and exit the **Vertical Alignment Generator**.

*** In order to save the profile, the COGO Redefine setting must be toggled on.

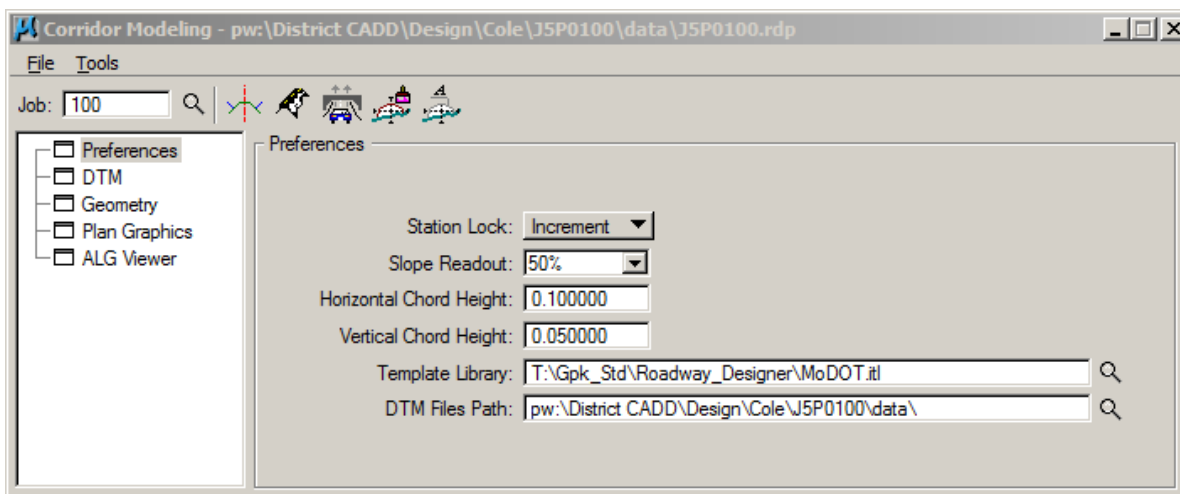
You may use D&C Manager to plot the profile **Ramp2PR**. If you do so **save** changes the MicroStation drawing.

28. Open the MicroStation file **Plan.dgn**.

29. From the GeoPak Road Tool Palette, select **Corridor Modeling**:



30. Load the **J5P0100.rdp** file and verify the settings in the **Preference** section:




31. Under the **Geometry** section import the following Chains and their Profiles:

<u>Chain</u>	<u>Profiles</u>	<u>Drafting Standard</u>
Route50	Route50EX, Route50PR	MoDOT Baseline Proposed
Ramp2	Ramp2EX, Ramp2PR	MoDOT Baseline Proposed

32. In Corridor Modeling in the **Plan Graphics** section import the following elements:


ROUTE50 EOP RT OUT

Lv Names: Roadway-Edge of pavement, **Colors:** 0

Symbology		Undisplay	Begin Offset: 40.00
Chain: ROUTE50		Side: R	End Offset: 70.00
New Chain Name: ROUTE50_EOP_RT_OUT		Filter Tolerances	Import
Drafting Standard: EOP_New		Horizontal: 50.00	
		Variance: 0.010000	

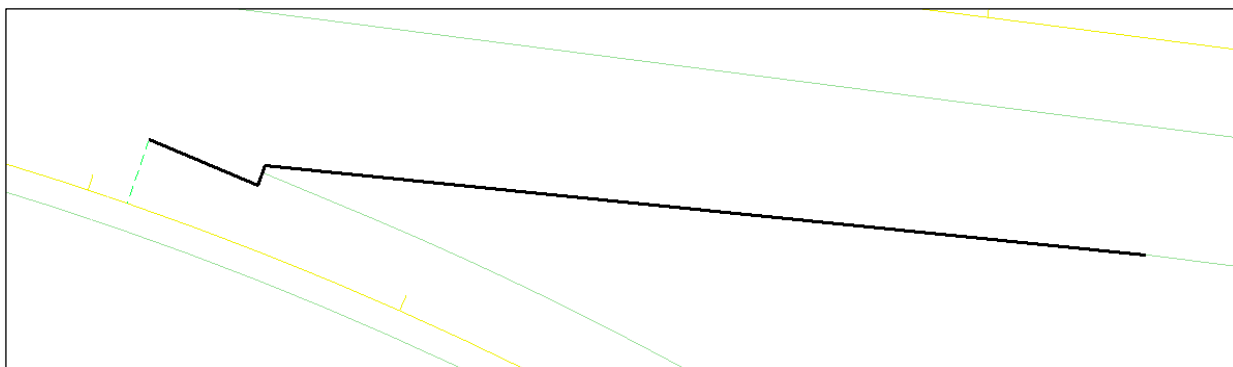
RAMP2 EOP LT

Lv Names: Roadway-Edge of pavement, **Colors:** 0

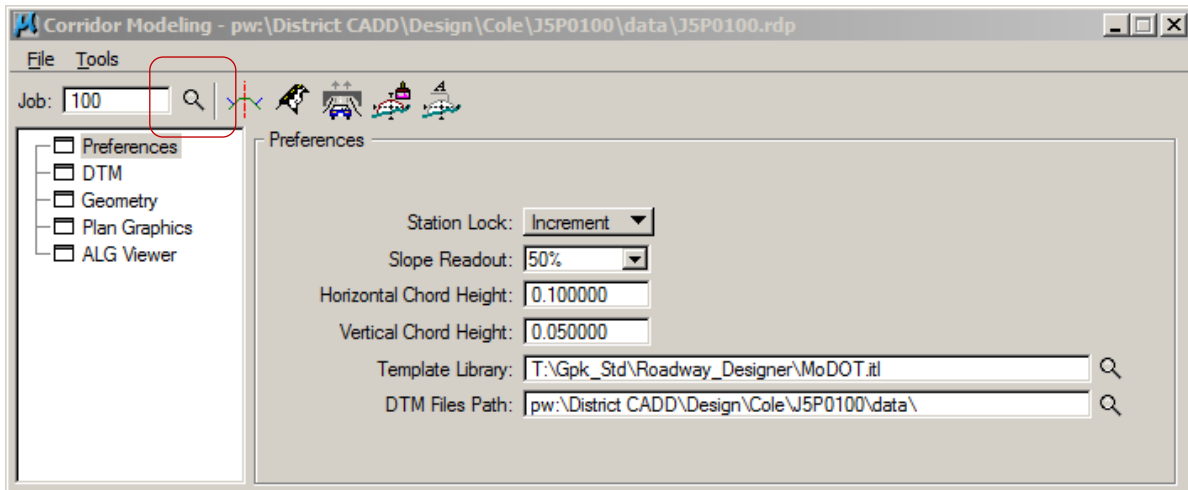
Symbology		Display	Begin Offset: 0.00
Chain: RAMP2		Side: L	End Offset: 20.50
New Chain Name: RAMP2_EOP_LT		Filter Tolerances	Import
Drafting Standard: EOP_New		Horizontal: 50.00	
		Variance: 0.010000	

ROUTE50 EOS RAMP2

Selection Set	Undisplay
New Chain Name: ROUTE50_EOS_RAMP2	Filter Tolerances
Drafting Standard: EOS_New_Asphalt	Horizontal: 50.00
	Variance: 0.010000
	Import



33. In the first few steps we are going to create a template that will be used for **Ramp2**. Select the **Open Create Template** icon.



34. In **Create Template** dialog under the **J5P0100** folder select “**File > New > Folder**” and create a folder called “**Route50**”.

35. Within the MoDOT Template section of the ITL right click and copy the **4-Lane Major Rural** and paste template into the **Route50** folder.

*Notes

- Delete the three bottom pavement and shoulder layers.
- Remove the 2ft buffer width next to the shoulders in the median.
- Merge the 3 points at the Edge of Shoulder leaving the **XX_Shldr_Surf_Asph_T3** point.
- Apply Shoulder Rollover Locks using the “**Rollover Values**” option in the Point Edit Dialog.
- Modify the fill slopes to default to 4:1
- Save Template Library

36. Notes – With the introduction of Rollover Values in this section the Hierarchy of Control now look like the following:

Template Point - Hierarchy of Control

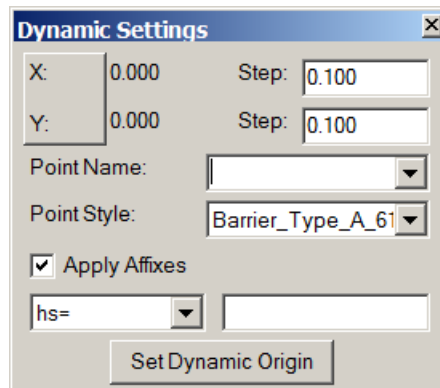
- Point Control - Highest
- **Style Constraint**
- **Rollover Values**
- Parametric Constraint
- Point Constraint - Lowest

The screenshot shows the 'Point Properties' dialog box. The 'Name' field is set to 'Shldr_Surf_Conc_T1_F'. The 'Surface Feature Style' is 'XS_Shoulder_Surface'. The 'End Condition Properties' section has 'Check for Interception' and 'Place Point at Interception' checked. The 'Constraints' section shows 'Constraint 1' with Type 'Slope', Parent 1 'Pvmt_Surf_Conc_T', Parent 2 checked, Value '-2.000%', and Label 'Shldr_Surf_Conc_Slop'. 'Constraint 2' has Type 'Horizontal', Parent 1 'Pvmt_Surf_Conc_T', Value '8.000', and Label 'Shldr_Surf_Conc_Widt'. The 'Style Constraint' is set to 'EOS_New_Concrete'. The 'Range' is '50.000'.

Even though Rollover Values are defined in the point properties dialog, the Rollover Values have a higher level of control than a Point Constraint.

37. In **Create Template** dialog under the **J5P0100** folder select “**File > New > Folder**” and create a folder called “**Ramp2**”.

38. Activate the Dynamic Settings dialog and set the Stop increment to **0.10** and turn on “**Apply Affixes**”.



39. Within the **Ramp2** folder right click and select **New > Template**. Name the template “**1 Lane Rural**”

Components:

Left Side

Pavement Combined Concrete
Shoulder Combined Concrete

Right Side

Shoulder Combined Concrete

End Conditions:

Left Side

Fill Slope 1 (4:1)
Ditch 1

Right Side

Fill Slope 1 (4:1)
Ditch 1

*Notes

- g) Delete the three bottom pavement and shoulder layers.
- h) Set the Pavement Slope = -2% (Sloping up from the baseline)
- i) Set the horizontal pavement width to -18ft
- j) Set the horizontal left should width to -4ft
- k) Turn off Style constraint for seeking EOP_New
- l) Apply Shoulder Rollover Locks using the “**Rollover Values**” option in the Point Edit Dialog.
- m) Check Priorities on End Conditions
- n) Save Template Library

40. In the **Roadway Designer** dialog, **create** and then **select** the **Route50** corridor. Use **Route50PR** as the **Vertical Alignment Profile**.

Start Station **Beginning of Chain**
End Station: **End of Chain**

41. In **Roadway Designer** apply the “**4 Lane Major Rural**” template to the **Route50** corridor. To do this select **Corridor > Template Drops**:

Station	Interval	Edits
Start of Chain	50	None
451+40.666	5	Remove Right Shoulder and End Condition
453+55.684	5	Remove Right End Condition and make Right shoulder 1 foot wide and outside EOS vertical.
453+90.552	50	None

42. To apply superelevation to **Route50** select “**Superelevation > Import Superelevation from Input File**”

Section: Route50
File: Shape_Route50.inp

43. In the **Roadway Designer** dialog, **create** and then **select** the **Ramp2** corridor. Use **Ramp2PR** as the **Vertical Alignment Profile**.

Start Station **Beginning of Chain**
End Station: **End of Chain**

44. In **Roadway Designer** apply the “**1 Lane Rural**” template to the **Ramp2** corridor. To do this select **Corridor > Template Drops**:

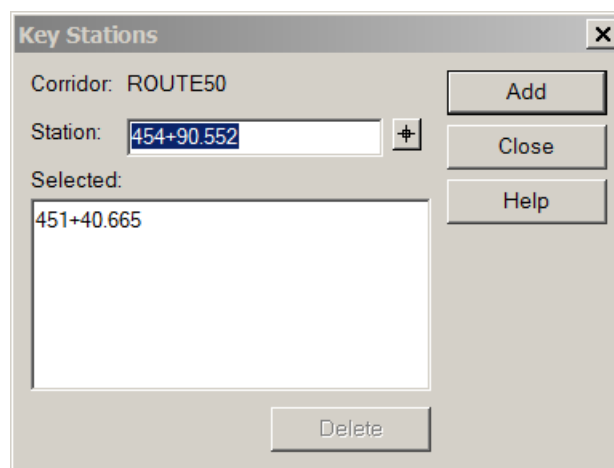
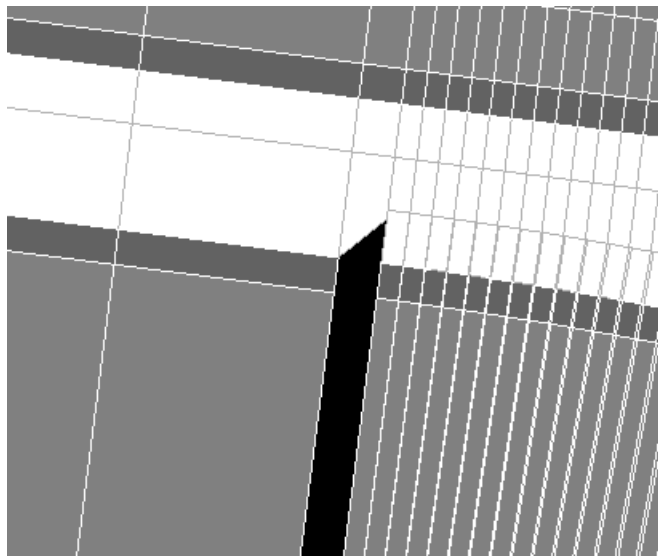
Station	Interval	Edits
Start of Chain	5	Remove Left Shoulder and End Condition
2+46.932	50	Modify pavement width to be 9’ wide
		None

45. To apply superelevation to **Ramp2** select “**Superelevation > Import Superelevation from Input File**”

Section: Ramp2

File: Shape_Ramp2.inp

46. To fix the gap at between **Route50** and the beginning of **Ramp2** we are going to add a key Station to the Route50 corridor just shy of the start of the ramp.



47. To fix the Vertical gap between the Route50 and the Ramp2 pavements we are going to use two Corridor Type Point Controls.

LEFT EOP RAMP2 TIES TO RIGHT EOP OF ROUTE50

Control Point = Pvmt_Surf_Conc_T1_L

Reference Point = RT_Pvmt_Surf_Asph_T1

Corridor: Ramp2

Control Description: LEFT EOP RAMP2 TIES TO RIGHT EOP OF ROUTE50

Point: Pvmt_Surf_Conc_T1_L

Mode:
☐ Horizontal
☒ Vertical
☐ Both

Control Type: Corridor Point

Corridor: ROUTE50

Reference Point: RT_Pvmt_Surf_Asph_T1

Station Limits:
 Start: 0+00.000
 Stop: 2+12.437

Horizontal Offsets:
 Start: 0.000
 Stop: 0.000

Vertical Offsets:
 Start: 0.000
 Stop: 0.000

Priority: 1

Horizontal and Vertical Controls:

E	P	Name	Start Stat..	Stop Station	Mode	Type	Control
X	1	Pvmt_Surf_Conc_T1_L	2+46.931	16+55.310	Vertical	Superelevation	Ramp2 Pvmt_Surf_Conc_T-Pvmt_Surf_Con...
X	1	Pvmt_Surf_Conc_T1_L	0+00.000	2+12.437	Vertical	Corridor Point	ROUTE50:RT_Pvmt_Surf_Asph_T1
X	1	Pvmt_Surf_Conc_T1_L	2+12.437	2+46.931	Vertical	Corridor Point	ROUTE50:RT_Shldr_Surf_Asph_T1

Delete

48. The second Corridor Type Point Control is as follows:

LEFT EOP RAMP2 TIES TO RIGHT EOS OF ROUTE50

Control Point = Pvmt_Surf_Conc_T1_L

Reference Point = RT_Shldr_Surf_Asph_T1

Corridor: Ramp2

Control Description: LEFT EOP RAMP2 TIES TO RIGHT EOS OF ROUTE50

Point: Pvmt_Surf_Conc_T1_L

Mode: ☐ Horizontal ☒ Vertical ☐ Both

Control Type: Corridor Point

Corridor: ROUTE50

Reference Point: RT_Shldr_Surf_Asph_T1

Station Limits: Start: 2+12.437, Stop: 2+46.931

Horizontal Offsets: Start: 0.000, Stop: 0.000

Vertical Offsets: Start: 0.000, Stop: 0.000

Priority: 1

Horizontal and Vertical Controls:

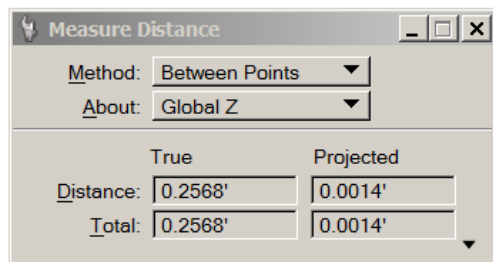
E	P	Name	Start Stat..	Stop Station	Mode	Type	Control
X	1	Pvmt_Surf_Conc_T1_L	2+46.931	16+55.310	Vertical	Superelevation	Ramp2 Pvmt_Surf_Conc_T-Pvmt_Surf_Con...
X	1	Pvmt_Surf_Conc_T1_L	0+00.000	2+12.437	Vertical	Corridor Point	ROUTE50:RT_Pvmt_Surf_Asph_T1
X	1	Pvmt_Surf_Conc_T1_L	2+12.437	2+46.931	Vertical	Corridor Point	ROUTE50:RT_Shldr_Surf_Asph_T1

Delete

49. To fix elevation difference between the **Route50** shoulder and **Ramp2** pavement use the parametric Constraint dialog to modify the slope of the **Route50** shoulder.

The elevation difference is **0.2568'**, the distance to apply that over is **12.1321'**.

Adjustment slope = $(0.2568/12.1321) = 2.1167\%$ (Down)

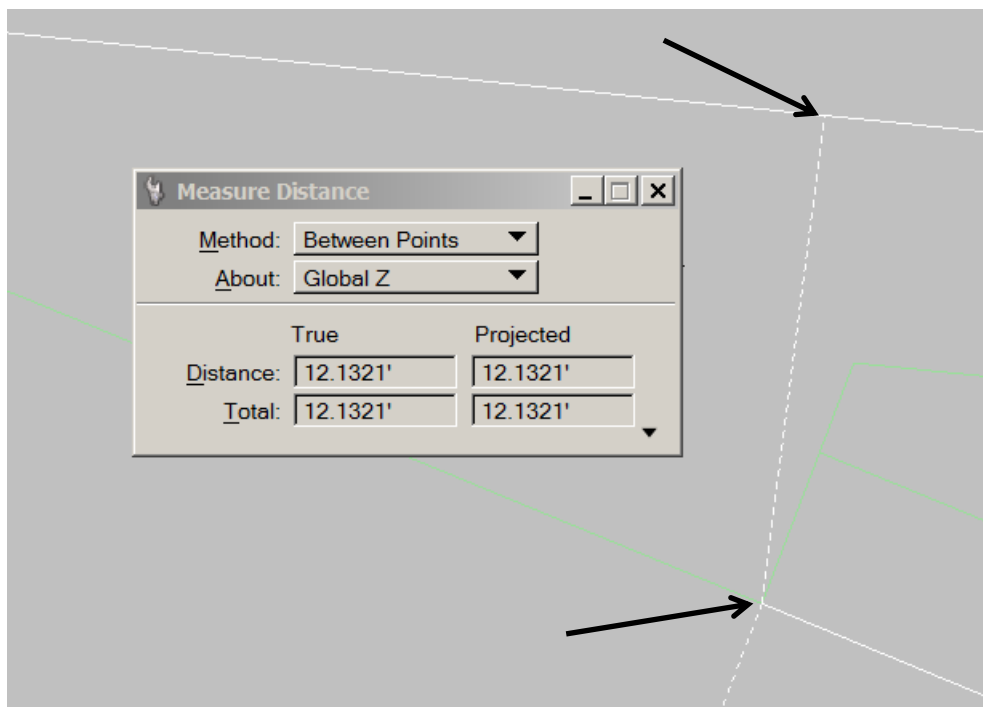
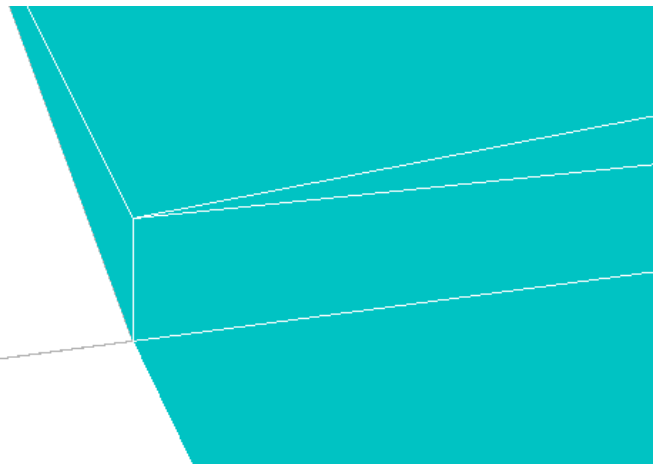


Measure Distance

Method: Between Points

About: Global Z

	True	Projected
Distance:	0.2568'	0.0014'
Total:	0.2568'	0.0014'



Measure Distance

Method: Between Points

About: Global Z

	True	Projected
Distance:	12.1321'	12.1321'
Total:	12.1321'	12.1321'

Two black arrows point to the start and end points of the measured distance on the road profile.

50. Open the Parametric Constraints dialog and setup as follows:

Parametric Constraints

Corridor: ROUTE50

Constraint Label: RT_Outer_Shldr_Asph_Slope

Start Value: -2.000%

Stop Value: -4.117%

Station Limits

Start: 453+55.684

Stop: 453+89.615

Buttons: Add, Close, Change, Help

Override Values:

Enabled	Name	Start Value	Stop Value	Start Station	Stop Station
X	RT_Outer_Shldr...	-0.020	-0.041	453+55.684	453+89.615

Buttons: Export..., Import..., Delete

51. In order for the parametric to work the Rollover Values for the Slope Constraint needs to be turn off.

Constraints

Constraint 1

Type: Slope

Parent 1: RT_Pvmt_Surf_Asph_

Parent 2: ☐ Rollover Values...

Value: -2.000%

Label: RT_Outer_Shldr_Asph

52. To fix elevation difference between the **Route50** shoulder and **Ramp2** 4' shoulder use the Parametric Constraint dialog settings to modify the slope of the **Ramp2** shoulder.

To get the Parametric Constraint to work in this area we need to turn off the shoulder Rollover lock. One way to do this is to drop another template after the grass gore point and then turn off the Rollover Lock in the grass gore template drop and set the shoulder slope to **-6%**. Also change the slope label to **LT_Shldr_Surf_Conc_Slope**

Drop the new Ramp2 Template Drop at station 3+50

The elevation difference is **0.1292'** (.1339) +/-, the distance to apply that over is 4'.

Adjustment slope = $(0.1323/4) = 3.331\%$ (Up)

The Measure Distance dialog box displays the following information:

	True	Projected
Distance:	0.1323'	0.0127'
Total:	0.1323'	0.0127'

Set the following Parametric Constraint:

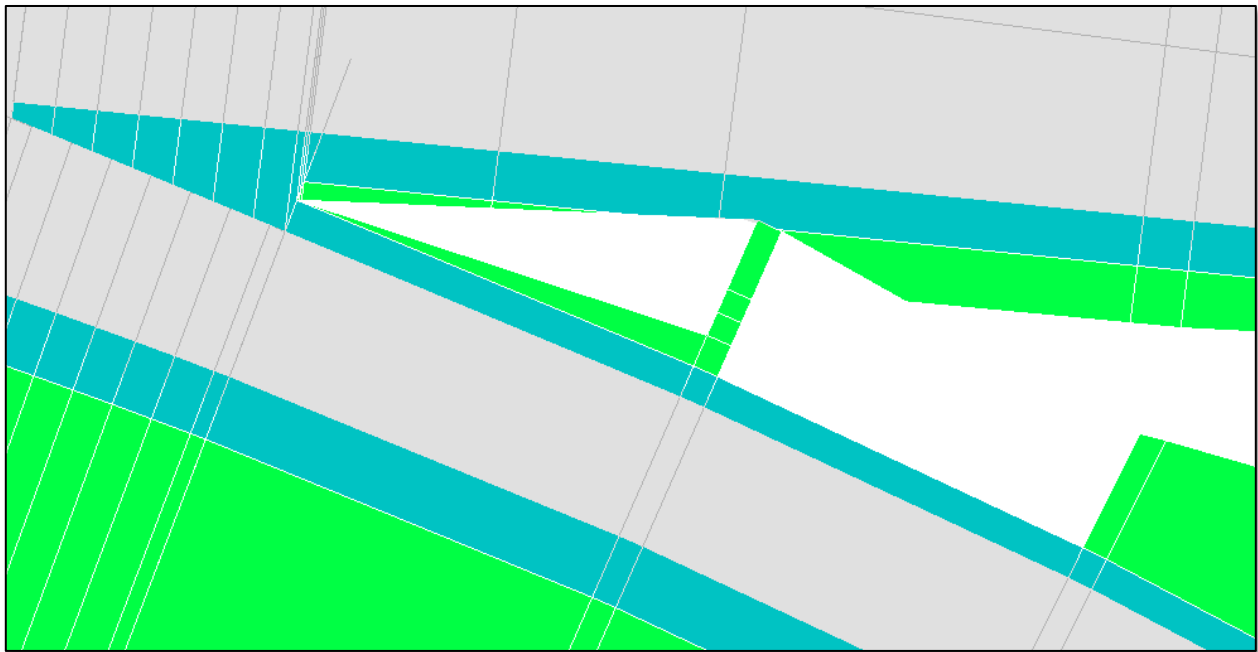
The Parametric Constraints dialog box shows the following settings:

- Corridor: Ramp2
- Constraint Label: LT_Shldr_Surf_Conc_Slope
- Start Value: -9.331%
- Stop Value: -6.000%
- Station Limits: Start 2+46.933, Stop 3+00.000

The Override Values table is as follows:

Enabled	Name	Start Value	Stop Value	Start Station	Stop Station
X	LT_Shldr_Surf_Conc_Slope	-0.093	-0.060	2+46.933	3+00.000

53. Lastly to fix the grass gore area do the following steps for the **Ramp2** Corridor:



- Edit the template in the 2+46.932 Template Drop and remove the Ditch End Condition.
- Change the 2+46.932 Template Drop interval to 5 feet.
- Set up the following Target Aliasing for the Ramp2 Corridor.

